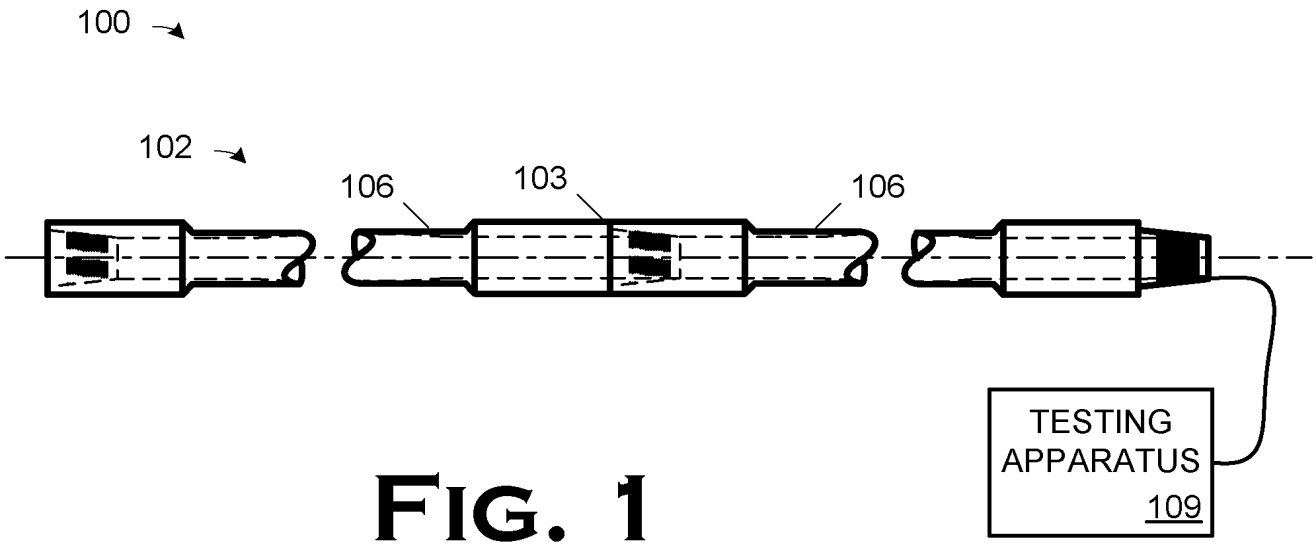
100
102
106
103
106
TESTING APPARATUS
109

FIG. 1

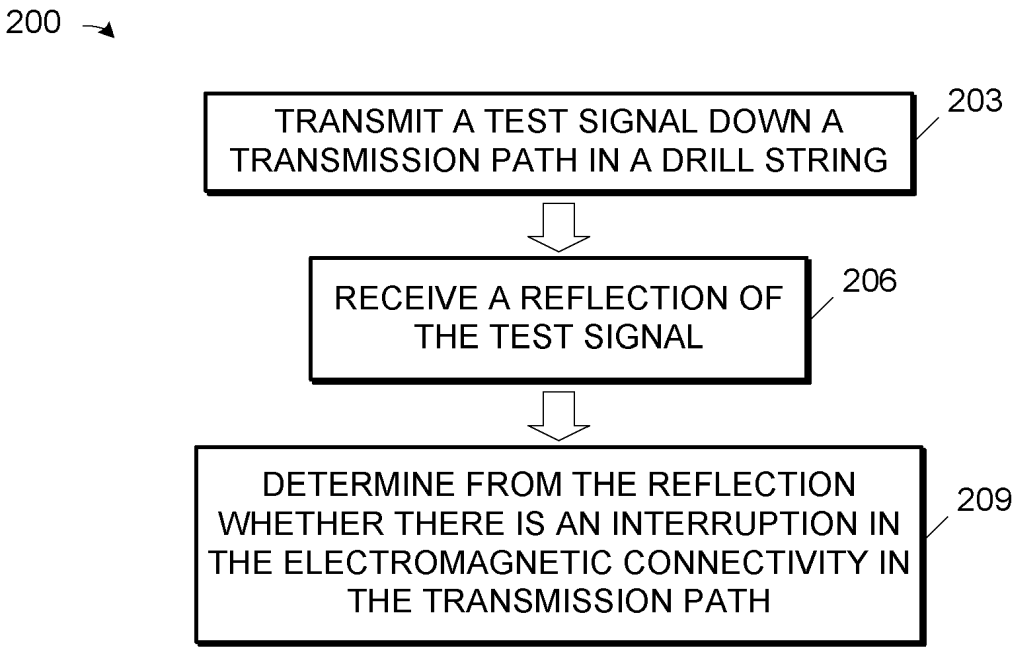
200
TRANSMIT A TEST SIGNAL DOWN A TRANSMISSION PATH IN A DRILL STRING
203
RECEIVE A REFLECTION OF THE TEST SIGNAL
206
DETERMINE FROM THE REFLECTION WHETHER THERE IS AN INTERRUPTION IN THE ELECTROMAGNETIC CONNECTIVITY IN THE TRANSMISSION PATH
209

FIG. 2

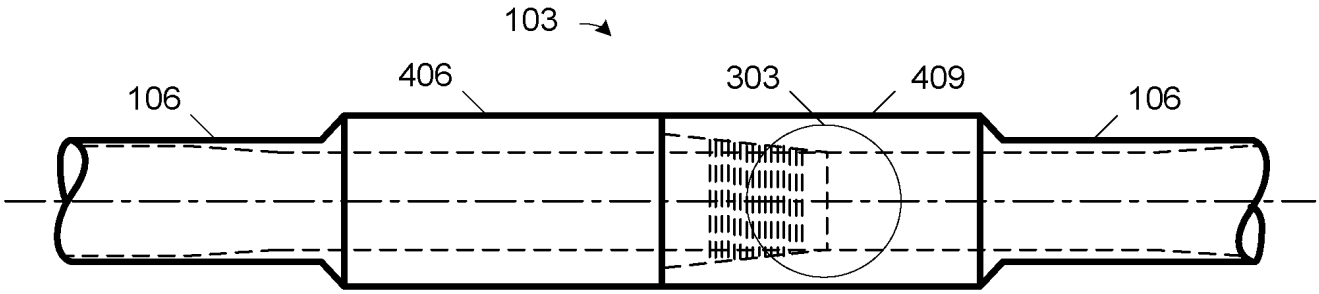

FIG. 3A

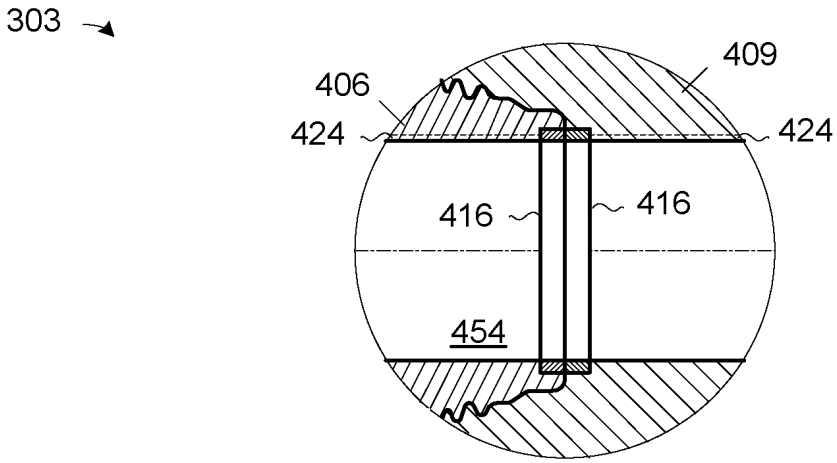

FIG. 3B

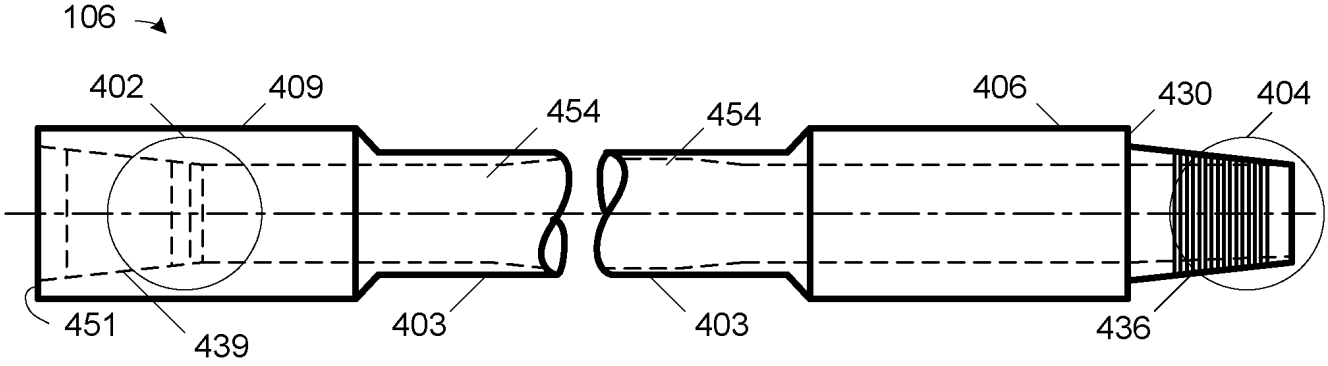

FIG. 4A

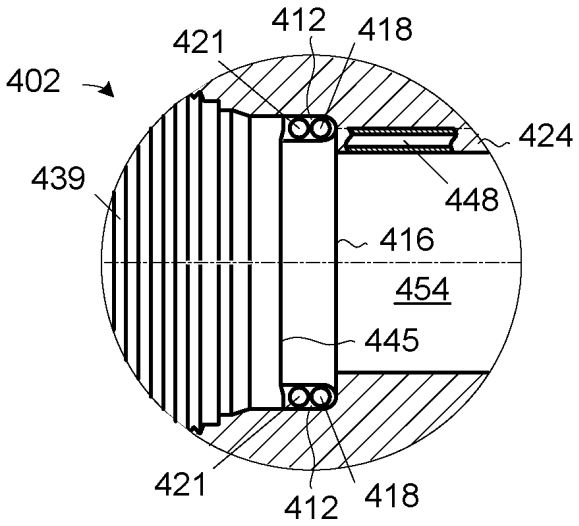

FIG. 4B

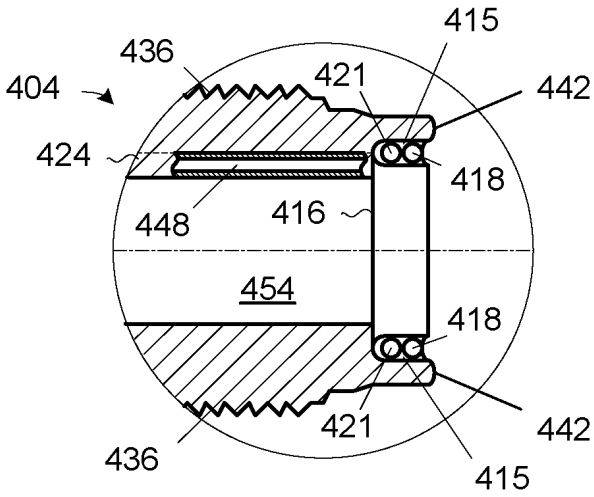

FIG. 4C

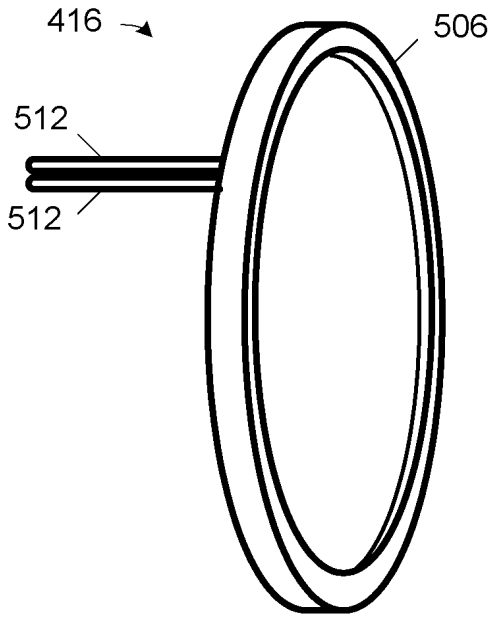

FIG. 5A

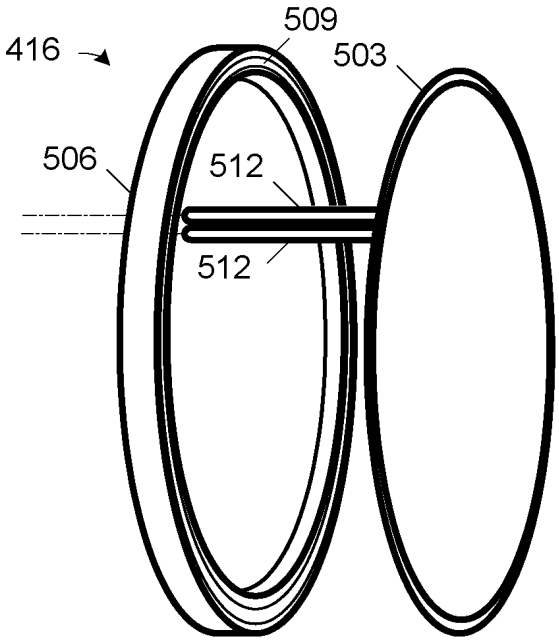

FIG. 5B

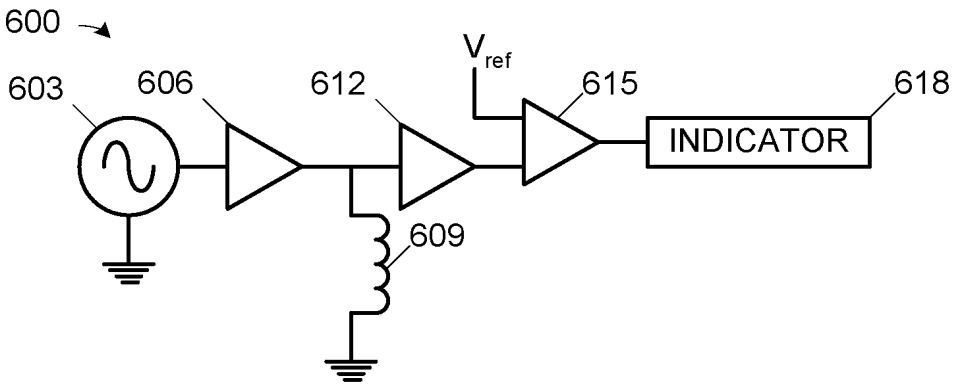
600
603
606
612
V_{ref}
615
618
INDICATOR
609

FIG. 6

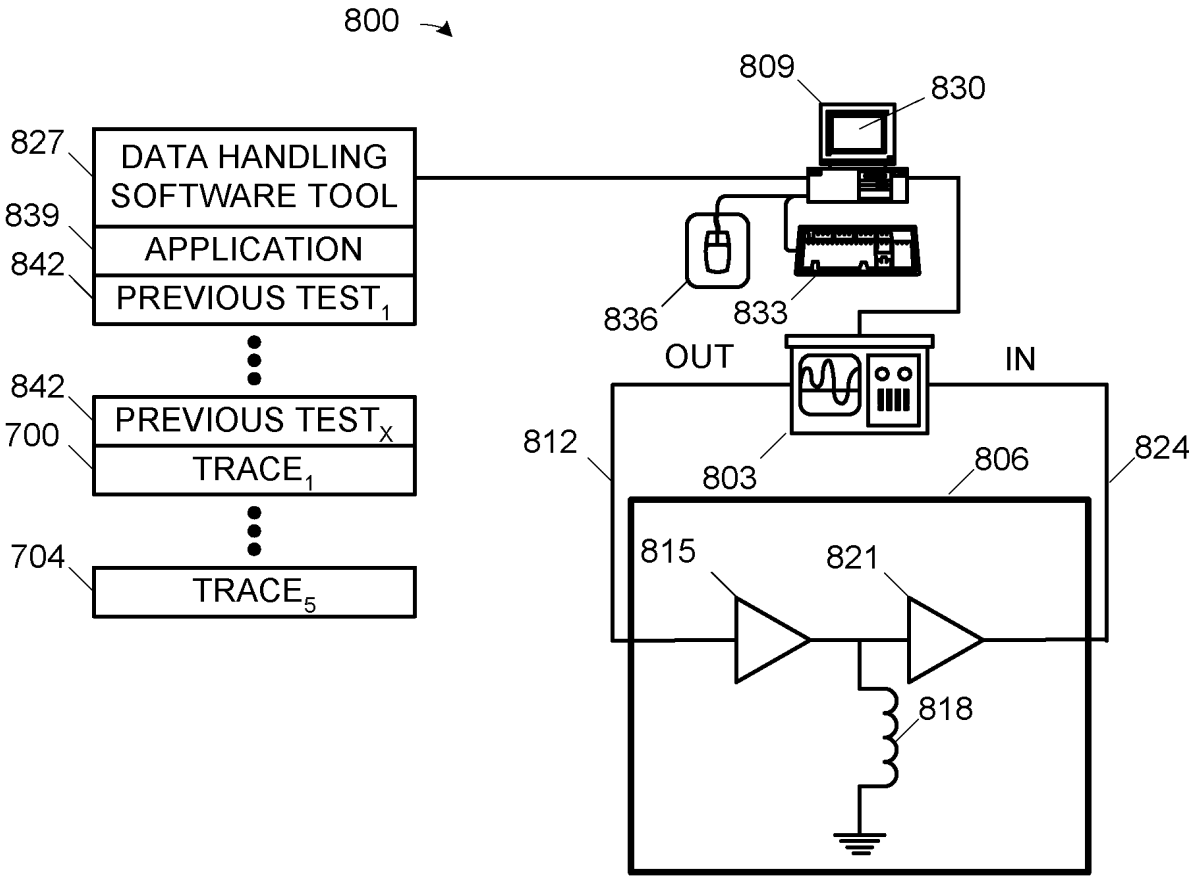
800
809
830
827
DATA HANDLING SOFTWARE TOOL
839
APPLICATION
842
PREVIOUS TEST$_1$
842
PREVIOUS TEST$_X$
700
TRACE$_1$
704
TRACE$_5$
836
833
OUT
IN
812
803
806
824
815
821
818

FIG. 8

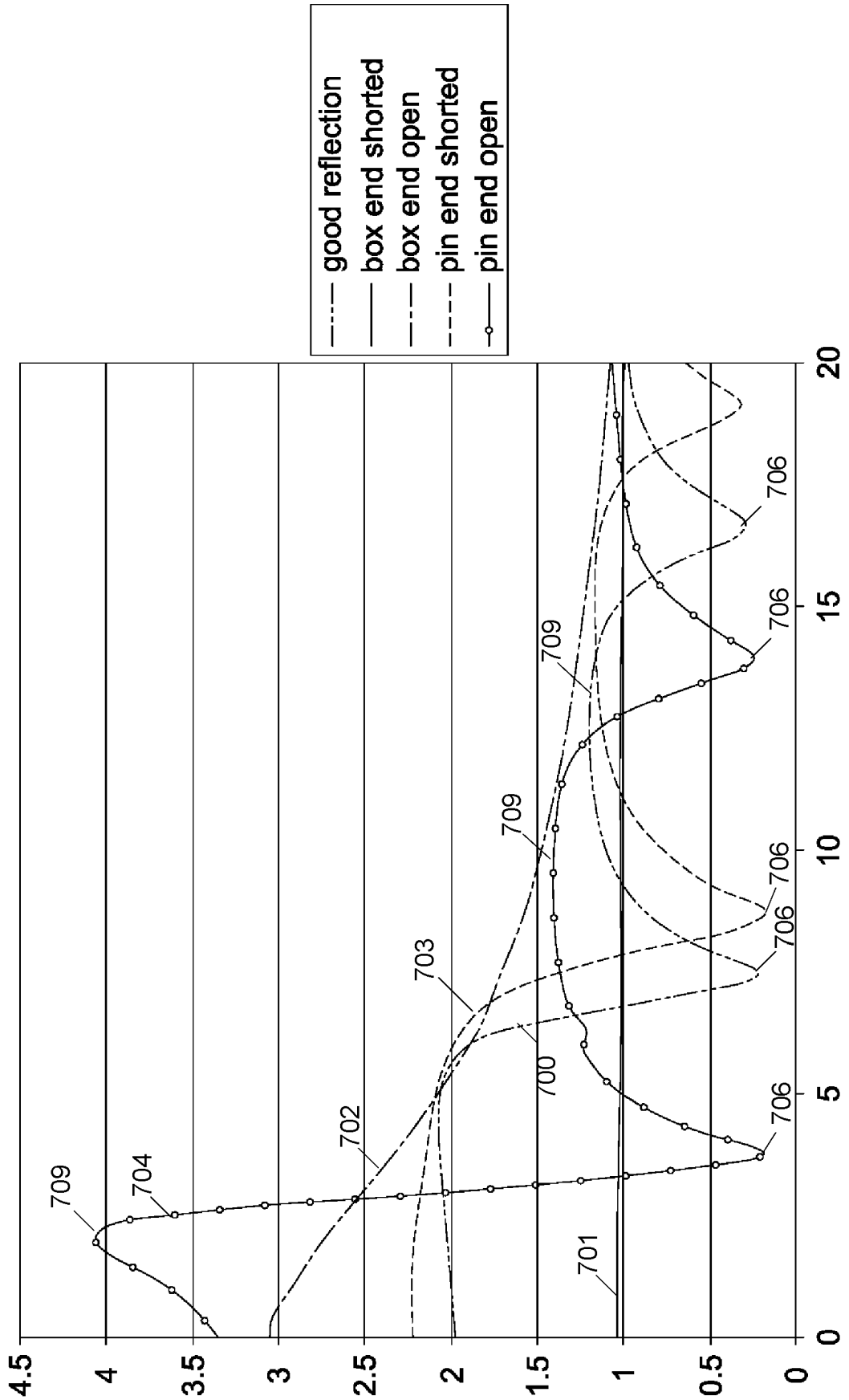
good reflection
box end shorted
box end open
pin end shorted
pin end open
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
709
704
702
703
709
709
706
706
706
706
706
700
701

FIG. 7

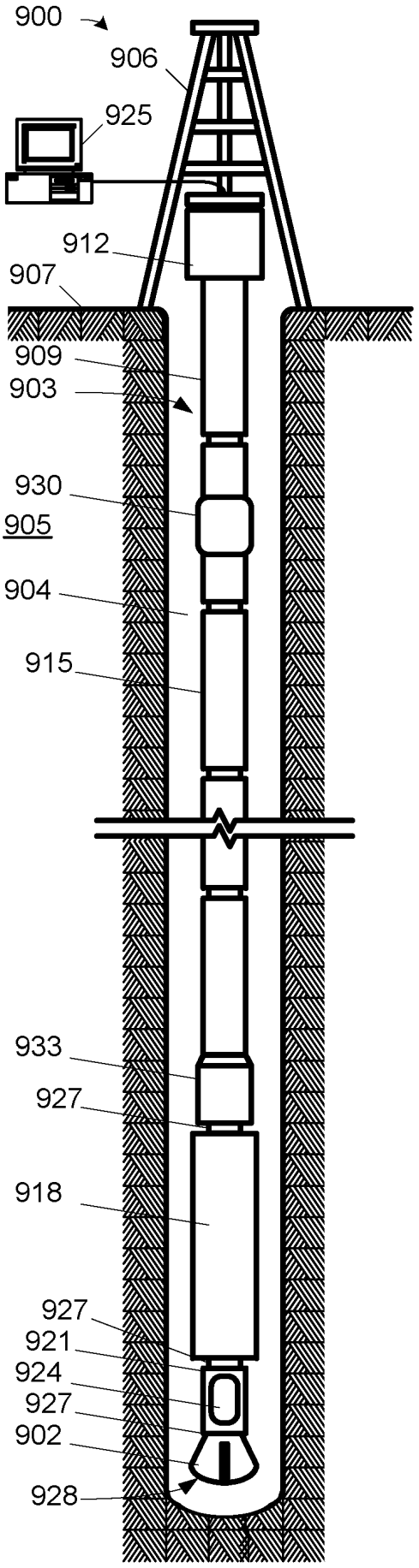
900
906
925
912
907
909
903
930
905
904
915
933
927
918
927
921
924
927
902
928

FIG. 9

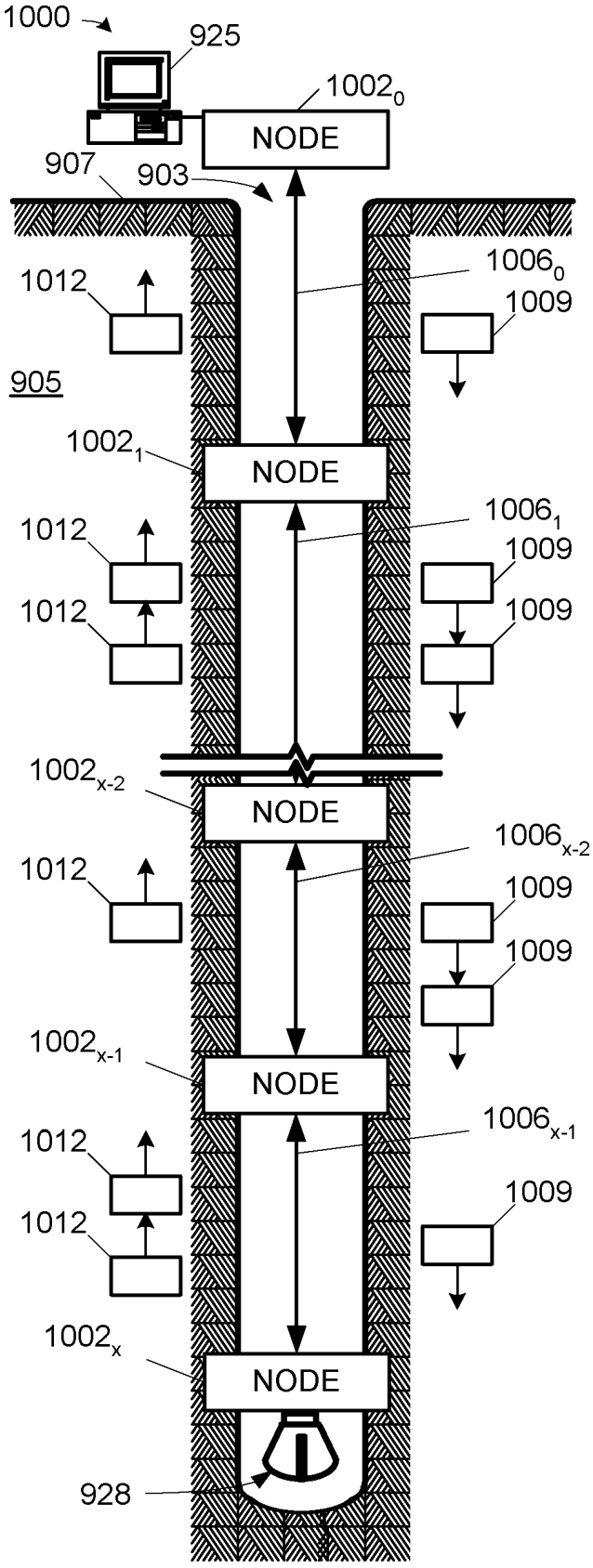
1000
925
1002$_0$
NODE
907
903
1012
1006$_0$
1009
905
1002$_1$
NODE
1006$_1$
1012
1009
1012
1009
1002$_{x-2}$
NODE
1006$_{x-2}$
1012
1009
1009
1002$_{x-1}$
NODE
1006$_{x-1}$
1012
1009
1012
1002$_x$
NODE
928

FIG. 10

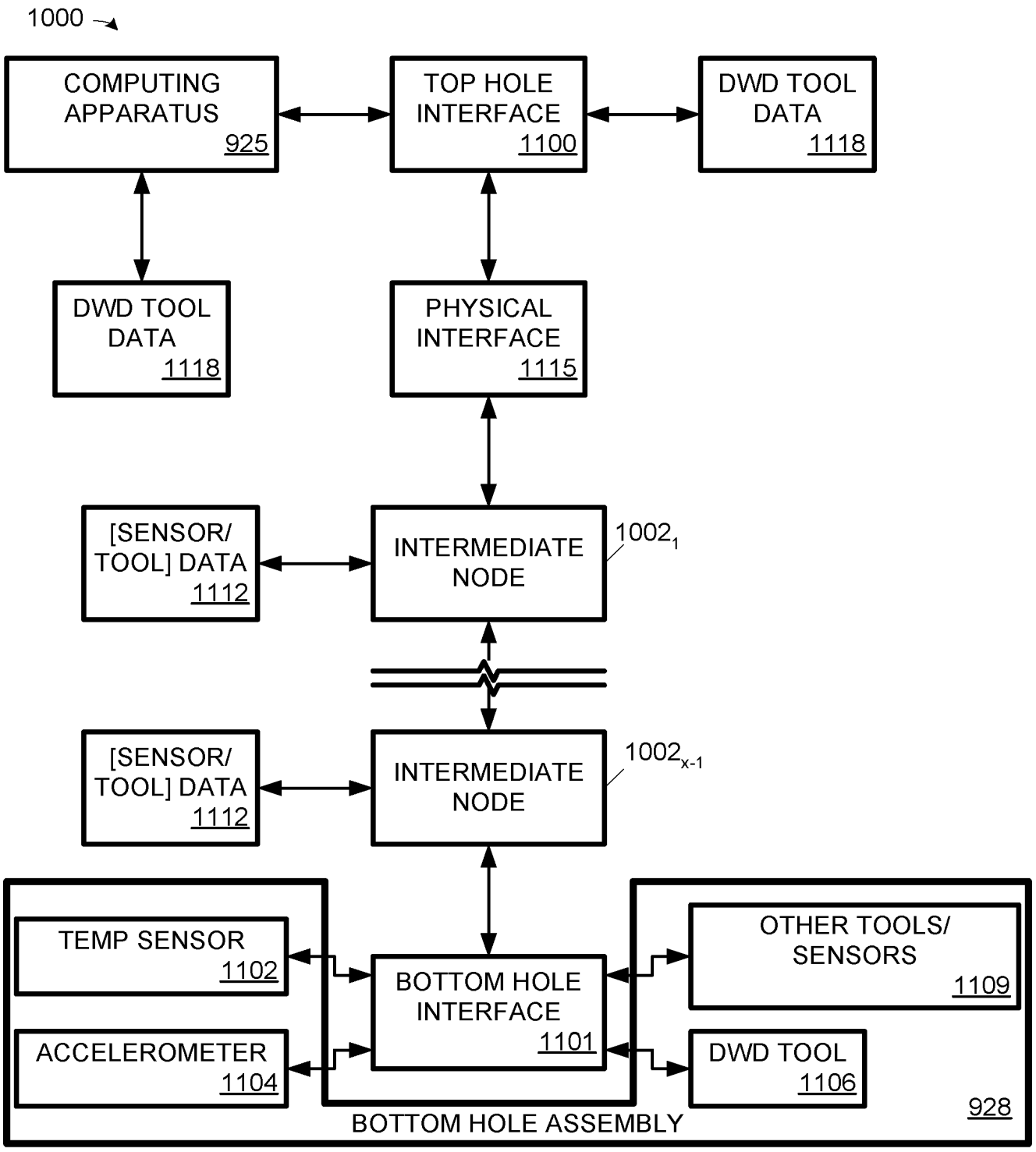
1000
COMPUTING APPARATUS 925
TOP HOLE INTERFACE 1100
DWD TOOL DATA 1118
DWD TOOL DATA 1118
PHYSICAL INTERFACE 1115
[SENSOR/ TOOL] DATA 1112
INTERMEDIATE NODE
1002$_1$
[SENSOR/ TOOL] DATA 1112
INTERMEDIATE NODE
1002$_{x-1}$
TEMP SENSOR 1102
ACCELEROMETER 1104
BOTTOM HOLE INTERFACE 1101
OTHER TOOLS/ SENSORS 1109
DWD TOOL 1106
928
BOTTOM HOLE ASSEMBLY

FIG. 11

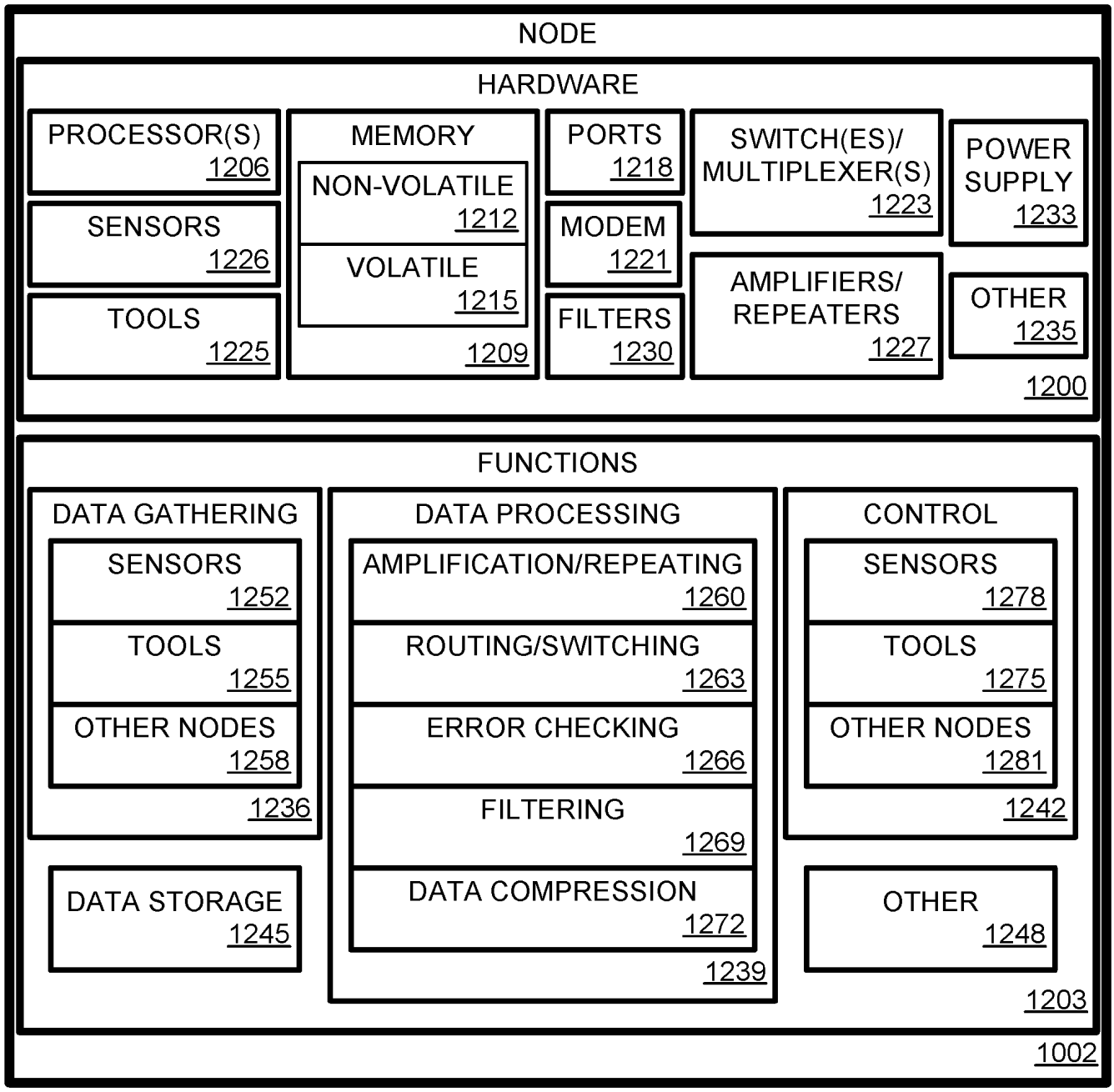
NODE
HARDWARE
PROCESSOR(S) 1206
SENSORS 1226
TOOLS 1225
MEMORY
NON-VOLATILE 1212
VOLATILE 1215
1209
PORTS 1218
MODEM 1221
FILTERS 1230
SWITCH(ES)/ MULTIPLEXER(S) 1223
AMPLIFIERS/ REPEATERS 1227
POWER SUPPLY 1233
OTHER 1235
1200
FUNCTIONS
DATA GATHERING
SENSORS 1252
TOOLS 1255
OTHER NODES 1258
1236
DATA STORAGE 1245
DATA PROCESSING
AMPLIFICATION/REPEATING 1260
ROUTING/SWITCHING 1263
ERROR CHECKING 1266
FILTERING 1269
DATA COMPRESSION 1272
1239
CONTROL
SENSORS 1278
TOOLS 1275
OTHER NODES 1281
1242
OTHER 1248
1203
1002

FIG. 12

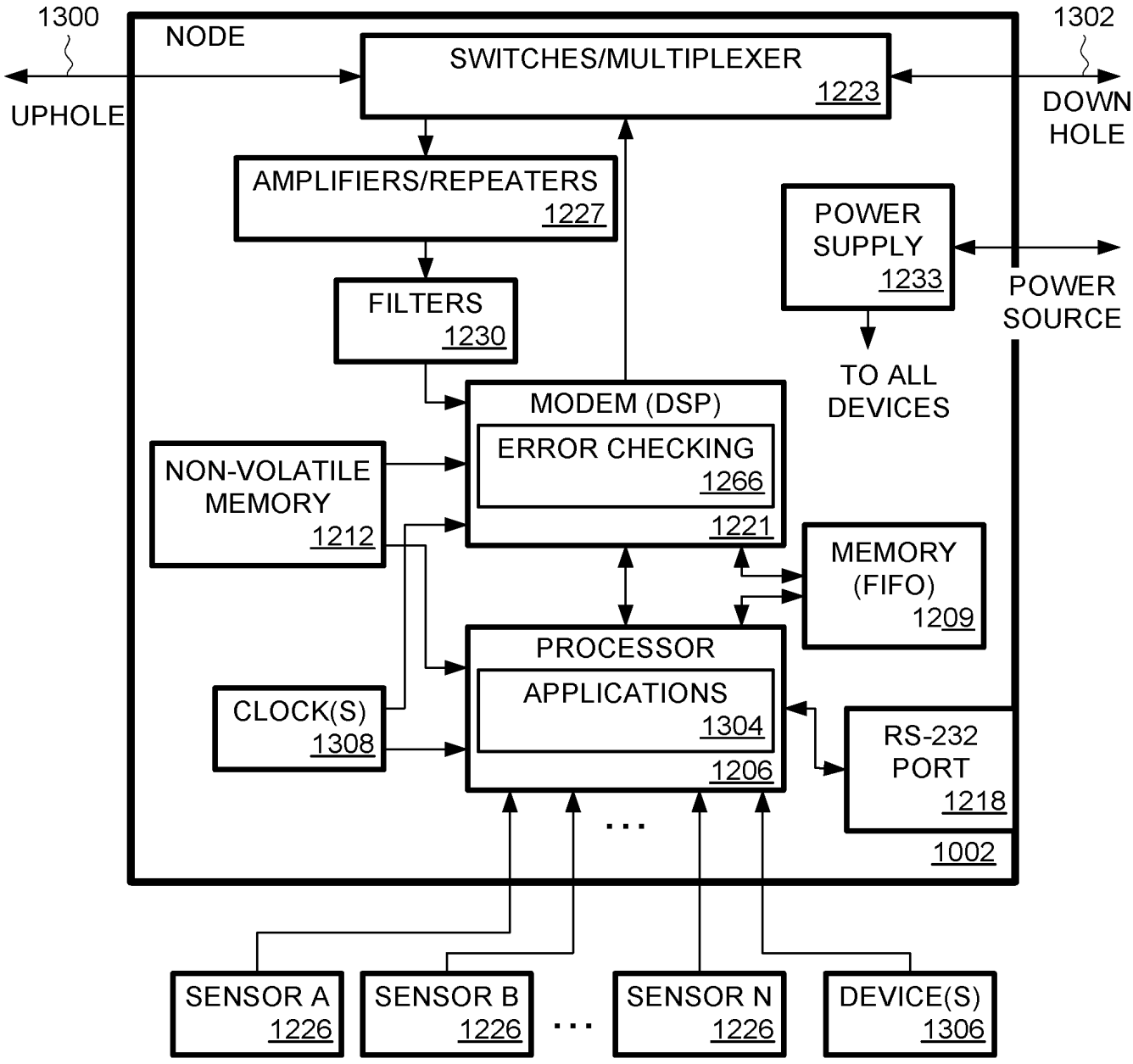
1300
NODE
1302
UPHOLE
SWITCHES/MULTIPLEXER
1223
DOWN
HOLE
AMPLIFIERS/REPEATERS
1227
POWER
SUPPLY
1233
POWER
SOURCE
FILTERS
1230
TO ALL
DEVICES
MODEM (DSP)
ERROR CHECKING
1266
1221
NON-VOLATILE
MEMORY
1212
MEMORY
(FIFO)
1209
PROCESSOR
APPLICATIONS
1304
1206
CLOCK(S)
1308
RS-232
PORT
1218
1002
SENSOR A
1226
SENSOR B
1226
SENSOR N
1226
DEVICE(S)
1306

FIG. 13

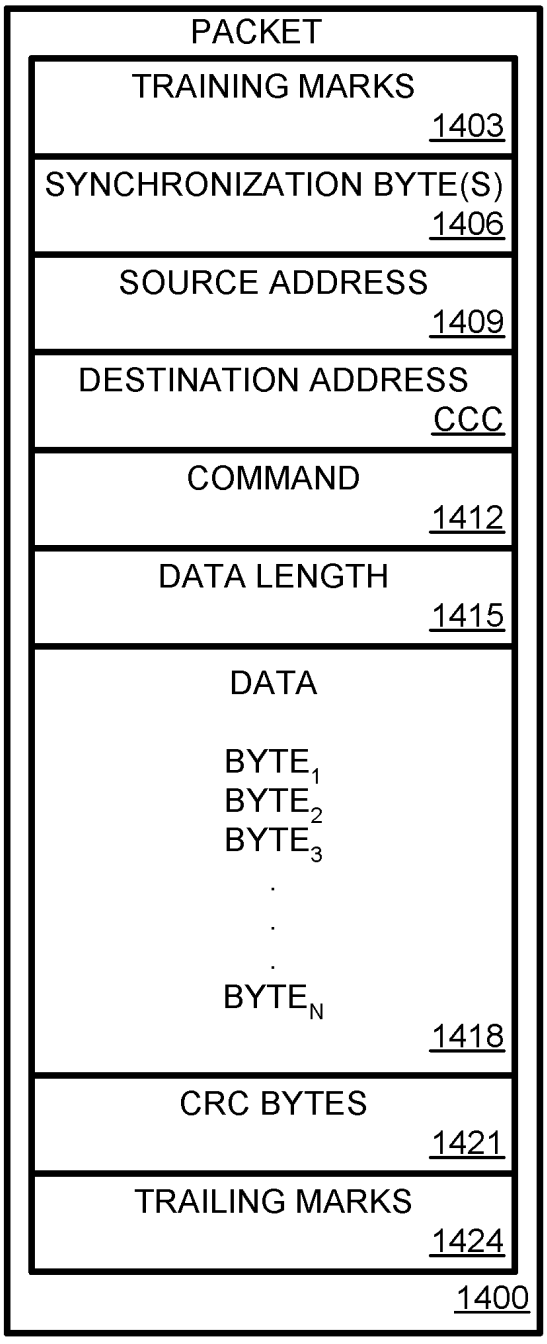
PACKET
TRAINING MARKS
1403
SYNCHRONIZATION BYTE(S)
1406
SOURCE ADDRESS
1409
DESTINATION ADDRESS
CCC
COMMAND
1412
DATA LENGTH
1415
DATA
BYTE1
BYTE2
BYTE3
BYTEN
1418
CRC BYTES
1421
TRAILING MARKS
1424
1400

FIG. 14